



Connected Vehicle-Enabled Weather Responsive Traffic Management

The Next Generation of Weather Responsive Traffic Management

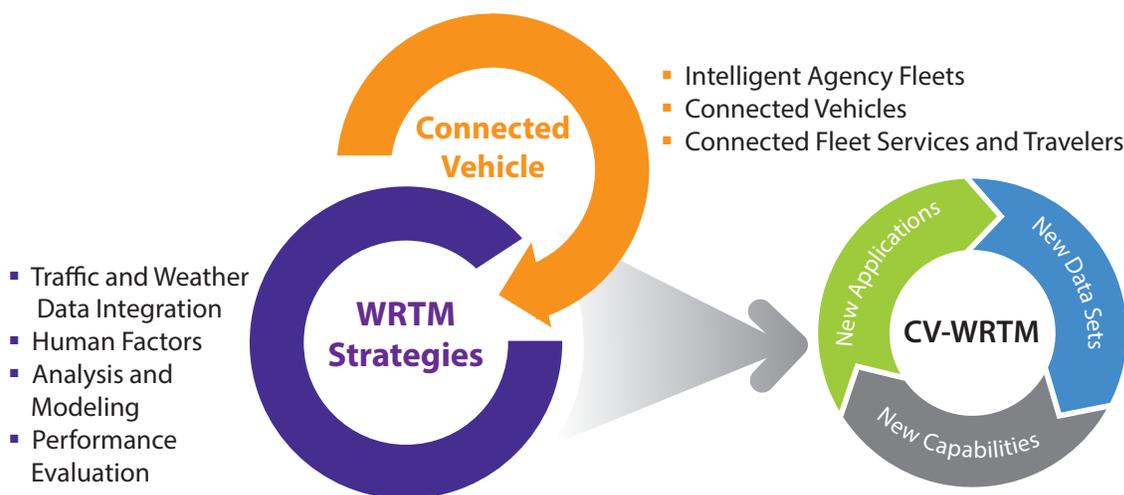
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Weather Responsive Traffic Management (WRTM) is a key initiative under the FHWA's Road Weather Management Program (RWMP). The WRTM initiative supports transportation agencies and professionals in developing better advisory, control, and treatment strategies that mitigate mobility and safety challenges due to adverse weather. It has enabled innovative and award-winning practices like citizen reporting systems, weather-responsive traveler information, and weather-responsive active traffic management.

The next generation of WRTM strategies needs to take advantage of advanced connected vehicles (CV) technologies (Figure 1). Connected vehicle-enabled

weather responsive traffic management (CV-WRTM) leverages vehicle connectivity to enhance WRTM processes and tools. Improved connectivity between transportation infrastructure and vehicles, as well as among vehicles themselves, presents unique opportunities for enhancing WRTM strategies by:

- Enabling communication (i.e., transfer of data) across users and transportation agencies;
- Expanding the coverage of the transportation network; and
- Providing more information on the network.



Source: FHWA

Figure 1. Leveraging connected vehicles for weather responsive traffic management.

Advancing CV-WRTM

FHWA has been supporting the acceleration of CV-WRTM by evaluating the state of the practice in WRTM strategies and road weather messaging, developing guidelines and informational materials, promoting CV-WRTM deployment through national workshops,¹ and collaborating with State transportation agencies to implement CV-WRTM strategies.

A review of the state of the practice in WRTM strategies and road weather messaging yielded a plethora of national and international initiatives. It showed that personalized information is not only emerging, but also desired by transportation network users. Moving to the next generation of WRTM that uses CV data can take different forms, and leveraging vehicle connectivity has multiple pathways. The FHWA-developed *Guidelines for Deploying CV-Enabled WRTM Strategies*² (also called *CV-WRTM Guidelines*) provides high-level guidance for agencies on advancing CV-WRTM using three distinct but related implementation pathways.



PATHWAY #1
Intelligent Agency

This pathway connects the agency's vehicle fleets to support WRTM strategies, typically by targeting vehicles that are frequent users of the roadway especially during adverse weather conditions, such as snowplows, highway patrol vehicles, and other maintenance vehicles. Building on the existing voice/radio connectivity that exists today, this pathway adds significant data collection and reporting capabilities which can support weather-responsive traffic management.

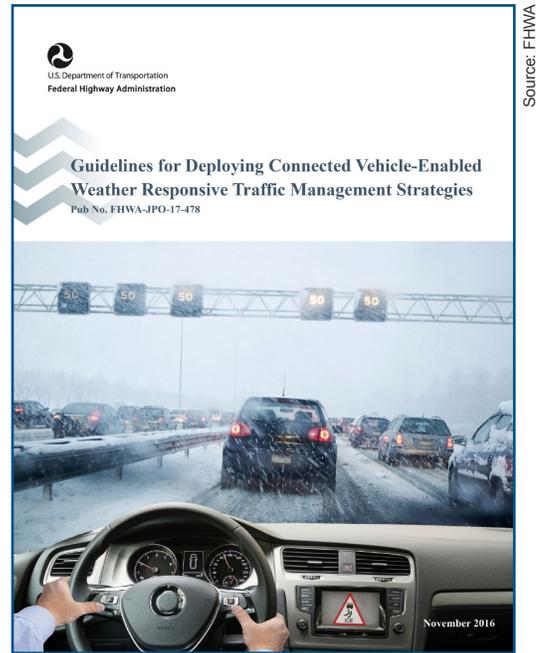


Figure 2. FHWA's *Guidelines for Deploying CV-Enabled WRTM Strategies* provides high-level guidance for agencies on advancing CV-WRTM.



PATHWAY #2
Connected Vehicles

A Connected Vehicle can transmit and receive Basic Safety Messages (BSMs) using the ITS band of 5.9 GHz (5.85 – 5.925 GHz). Pathway #2 focuses on the role of private connected vehicles and relies on the possibility that government regulation might require all light vehicles to have dedicated short range communication (DSRC) capabilities. DSRC is a networking technology that allows for fast, secure, and reliable communications for various vehicle to vehicle (V2V), vehicle to infrastructure (V2I), and vehicle to nomadic device (V2X) applications. Vehicles equipped with DSRC could communicate with each other, as well as with DSRC-enabled roadside units.

¹ The 4th National Stakeholder Meeting on Weather Responsive Traffic Management (WRTM) was conducted in Raleigh, North Carolina, on August 29-30, 2017. The summary report and presentations can be viewed and downloaded from <https://collaboration.fhwa.dot.gov/dot/fhwa/RWMX/default.aspx> under 'Documents' menu.

² FHWA, *Guidelines for Deploying Connected-Vehicle Enabled Weather Responsive Management Strategies*, FHWA-JPO-17-478, (Washington, DC; November 2016). Available at: <https://rosap.ntl.bts.gov/view/dot/31928>.



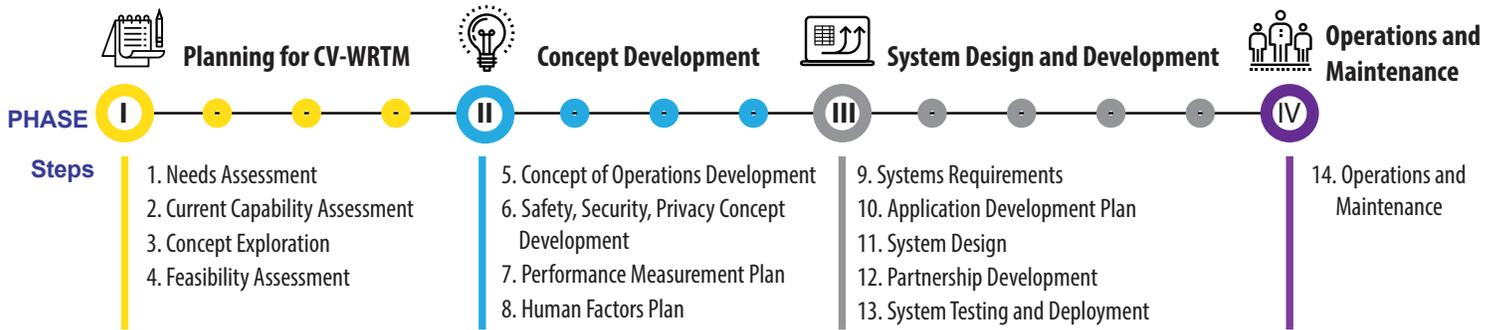
PATHWAY #3

Connected Third-Party Fleet Services and Travelers

In parallel with State agency fleet efforts, several private fleets are becoming extensively connected and can potentially send and receive information that is vital to WRTM. There are many private sector services and organizations that are looking at equipping fleets with their equipment or enabling data collection through an app on a nomadic device. Not reliant on DSRC adoption, data from these third-party sources can provide information that is often difficult or costly for a public agency to collect. The difference between Pathway 1 and Pathway 3 is the reliance on third-party providers to provide and receive data from the public agency.

Using CV technology effectively for WRTM requires new capabilities, partnerships, and agreements, as well as the improvement of existing tools.

The three pathways are not mutually exclusive, and all lead to leveraging connected vehicles for WRTM. The pathways build on each other and provide unique value to potential system deployments. Regardless of the pathway selected, four successive phases of CV-WRTM deployment address the planning, concept development, system design and development, and operations and maintenance activities (Figure 3). Each phase consists of step that need to be accomplished by an implementing agency.



- **Phase I** includes the steps necessary to plan for CV-WRTM. Ideally, the steps should be followed during the conceptualization stage or at the beginning of the planning stage of any envisioned CV-WRTM deployment.
- **Phase II** builds upon the findings in Phase I to develop a cohesive and coherent concept of operations and the necessary safety, performance, and human factors plans.
- **Phase III** provides specific information needed to design, develop, and deploy the CV-WRTM system including partnerships, procurement, and deployment plans.
- **Phase IV** describes what will be required to manage and maintain the system in order to achieve expected and desired performance outcomes.

Figure 3. Phases of CV-WRTM deployment.

Source: FHWA

The *CV-WRTM Guidelines* provide a State or local transportation agency with a concise summary of information and resources necessary to begin using connected vehicle data for weather-responsive traffic management.



CV-WRTM Implementation Projects

FHWA collaborated with Washington State DOT (WSDOT) and Delaware DOT (DeIDOT) to apply relevant pathways and phases of CV-WRTM deployment. The agencies reviewed the *CV-WRTM Guidelines* and proposed the pathways and applications that meet their needs (see Table 1).

Table 1. CV-WRTM pathways and applications being implemented.

PATHWAYS AND APPLICATIONS	WASHINGTON STATE DOT	DELAWARE DOT
PATHWAYS		
1-Intelligent Agency Fleets	■	■
2-Connected Vehicles		
3-Connected Third-Party Fleet Services and Travelers	■	
APPLICATIONS		
CV-WRTM Variable Speed Limits		
I2V Situational Awareness	■	■
V2V Situational Awareness		

Washington State DOT focused on public-private and third-party partnerships to share agency snowplow and specialty fleet data through an enhanced WSDOT traveler information application programming interface (API), with a goal of increasing safety and creating a more weather-aware motorist. Their CV-WRTM implementation demonstrated data flow from agency vehicles to a newly built API that was made available to potential internal and external users. Mobile data was collected from the majority of WSDOT snowplows (about 500 vehicles). Data includes timestamps, GPS data, ambient and road surface temperatures, and spreader location. Plow

position was not achieved due to sensor issues, but will be incorporated in the near future. WSDOT will continue to address the technical issues and system enhancements to have a fully functioning system by October 2018, operate it through the 2018-19 winter season, and document the evaluation results in 2019. WSDOT will continue to work with internal and external partners to fully realize the benefits of the shared mobile data.

Delaware DOT focused on adding mobile road weather devices to agency vehicles to help fill gaps in data collection coverage and using the data to improve traffic management operations and expand traveler information. Additionally, the new road weather data would assist in dispatching snowplows, maintenance vehicles and portable ITS equipment, and in identifying weather hotspots in order to better locate fixed devices for permanent system monitoring. DeIDOT recently completed the procurement process to acquire the new road weather mobile data sensors. Installation, testing, and full operation are currently underway. DeIDOT views this project as just the beginning to support DeIDOT’s CV-WRTM program. DeIDOT plans to complete this implementation project, including installing and testing eight mobile data collection devices, integrating the data into the DeIDOT TMC, using the data to enhance traffic and maintenance operations, and documenting the evaluation results. They will use the outcomes to launch an expanded effort to outfit additional vehicles in the future.

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For more information on the *CV-WRTM Deployment Guidelines*, the state of the practice review of WRTM strategies and road weather messaging, and status and results of the deployment projects, please contact:



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